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(Lodged electronically) **2 February 2023**

# Review of the Frequency Operating Standard (Ref. REL0084) Response to the Draft Determination

Delta Electricity operates the Vales Point power station situated at the southern end of Lake Macquarie in NSW. The power station consists of two 660MW conventional coal-fired steam turbo-generators. Delta Electricity commends the Reliability Panel for the process and efforts taken in this review and appreciates the opportunity to respond further.

Generally, the proposed changes are supported particularly where they are addressing the focused issues. An assigned rate of change of frequency (RoCoF) limit, the removal of the limit for accumulated time error expectations and correction to the wording associated with supply scarcity seem appropriate. No limit on contingency events on the mainland is also supported.

However, the nature of some of the changes could be further considered to clarify some minor outcomes that might arise from misinterpretations of the words used and applied differences due to those words and, in particular, the choice of the determined primary frequency control band (PFCB) has missed some points that were trying to be made by some participants.

The wording for the RoCoF limits needs more careful consideration as it could be misunderstood and could be presenting a standard better than the assigned value. If the standard is 1Hz/s then the standard is 1Hz/s but 500mHz in 0.5s could be associated with conditions that in any two consecutive 0.5s intervals don't exceed 1Hz/s so the reference to 1Hz/s is less clear. The wording change proposed for the former supply scarcity conditions would benefit from refined words that expand upon the meaning to include reference to load restoration as suggested by other participants at the public forums.

The decisions determining the assigned PFCB may have additionally benefited from a detailed independent examination of actual recorded frequency conditions to complement the well performed modelling that, despite a valuable contribution, did not seek to model the erraticism observable in actual system data at significant amplitudes relative to the PFCB. Strengthened wording that the required frequency outcome is 50Hz is meaningless without an accepted error (for rapid changes inside NOFB conditions) that may have been able to target acceptable erraticism and set a quality target for the at present uncontrolled condition. Perhaps the NOFB bands remain the "quality" guide in the views of the panel. Why then do we also need the PFCB? The existing erraticism combined with the very narrow determination for the PFCB may be prematurely ageing already old machines, shortening the life during a critical phase of the energy transition when they may still be needed to operate. The overly narrow settings are not yielding the expectations from the modelling, which examination of actual frequency data demonstrates, in which case some of the tight control is probably uncoordinated, over reactionary and will be contributing to wearing all machines in the NEM more than is necessary. A wider setting could have been proposed in the determination but, as the panel may be thinking, AEMO are already capable and empowered to propose wider deadbands in implementing mandatory PFR as specified in the primary frequency response (PFR) requirements (PFRR) currently under review. Without a guide for the acceptable quality of frequency in the Frequency Operating Standard (FOS), however, AEMO may lack incentive to improve the quality and seek to reduce or, preferably, eliminate erraticism in NEM system frequency.

**Dependency on AEMO Technical Advice**

This standard ought to be an authority, independently determined by the Panel, that assigns the targets for all frequency control objectives. The instigation of a PFCB has been initiated by AEMO, via a market request and market consultation as delivered by the AEMC, prior to engagement with the Reliability Panel that, in best practice, ought to independently be able to

determine what the national electricity market (NEM) needs from a technical perspective. The 'needs' may not always be what an operator feels can be presently delivered but, if necessary, after independent evaluation, the panel may seek to have the operator find the mechanisms to do so for the greater good. Moreover, the economic and engineering reasoning for each aspect of the standard ought to be adequately described within the (FOS) so anyone referencing the Standard at any time can clearly connect between each target and the specific economic and technical objectives the target represents.

According to AEMO, previously accepted by the AEMC and now accepted by the Reliability Panel by this FOS review, the existing standard was inadequate in some way by lacking a defined PFCB that, mandatorily applied by Rule changes that preceded this review, is now yielding effective equivalent conditions of a system assigned a Normal Operating Frequency Band (NOFB) of +- 0.06Hz instead of the +-0.15Hz defined in the FOS and unchanged by this review. The draft determination proposes that the PFCB, originally conceived unilaterally by AEMO based on some theoretical advice and urgently requested due to 2018 AEMO concerns that system security was under threat from a lack of PFR inside +-150mHz, be consolidated into the FOS. If the conditions described by the 99 percentile NOFB of +-0.15Hz remain valid, it is puzzling why the FOS review proposes to uphold a PFCB that is delivering apparent conditions that represent a NOFB of +- 0.06Hz. It is likely that a wider PFCB, or more importantly, greater variation of deadbands of NEM frequency controllers as driven by the PFRR, will yield a better and more coordinated frequency condition than the mandated PFR and PFCB is doing now. The PFCB set at the tight level defined by Mandatory PFR appears not to provide the modelled expectations and many existing controllers are not able to coordinate adequately in attempting to control to it, in which case, although theoretically considered to be a 'better' determination, practical conditions suggest otherwise or at least that other options exist to avoid unnecessary wear on all electrical machines in the NEM. It is probable that wider deadbands can produce the same conditions now being experienced and reduce unnecessary wear on all machines. Conditions to reduce the wear on all machines ought to also be a target. Varied deadbands and some AGC changes would also produce a more coordinated frequency condition. However, AEMO hold a strong preference that the PFCB should remain +-15mHz despite also having the capacity, or the obligation, to control frequency and may, in the near future, realise the need for variations in assigned deadbands. The FOS limits and the Rules don't mandate that deadbands should all be at the PFCB value but the Rules suggest the PFRR should not assign deadbands narrower than the PFCB. The Panel is no doubt aware of this and maybe is therefore satisfied that the determined value is adequate in absence of any other evidence that might suggest a wider PFCB could produce the same conditions.

It is understood that AEMO advice is essential to be obtained in considering important technical standards such as the FOS. However, Delta Electricity suggests to the Panel that it is also necessary for the Panel to remain partially sceptical of the AEMO advice regarding the FOS. Ensuring the NEM is operated to the FOS is a Rules assigned obligation for AEMO. There is a potential conflict of interest in advice from AEMO although this does not mean to suggest the operator would intentionally act in such a way just that the potential exists that warrants some separation by the panel from total reliance on the advice. Assigning targets in the FOS which are only what an Operator either proposes or accepts may sometimes represent an unreasonable, unnecessary and/or inefficient burden upon other NEM participants or, in the absence of other advice from an operator regarding how they also could address other issues such as the overall quality of normal frequency conditions, consideration by the Panel of additional quality targets that could save wear and tear costs for all electrical equipment operated in the NEM, might be overlooked because the Operator, in not wanting the burden of the additional monitoring and tuning work necessary to meet such targets, doesn't suggest such targets and/or doesn't agree conditions necessitate them.

It is suggested the Panel needs to read carefully between the lines of advice from AEMO and then also have the fortitude to, where appropriate, propose other targets that may be lacking in the Standard that the Operator either does not propose or does not support. If the Panel cannot determine, independently of AEMO advice, what is appropriate for the FOS, then they should seek advice from other consultants with an equal understanding of world-wide operating conditions. For example, GHD were asked to present worldwide experiences regarding RoCoF but could have also been asked to consider experiences with frequency quality. However, perhaps there is also no worldwide advice or actions currently underway seeking to address the quality of frequency control during the transition in energy sources from natural synchronous systems to asynchronous and inverter-based generation, in which case, the Panel may have missed an opportunity to lead the world in considering, then defining, such quality targets to steer AEMO, and other participants, in taking actions necessary to meet them.

Prior to Mandatory PFR Rules being developed, technical personnel from various market participants in the NEM demonstrated to the AEMC and AEMO, that the pattern and distribution of frequency being experienced in operation within the Normal Operating Frequency Band was irregular compared to pre-NEM conditions. The erraticism presents potential consequential impacts increasing machine wear and tear, downtime and repair costs. Mandatory PFR was

pursued in Rule changes as requested by AEMO. Erraticism in frequency conditions persists post Mandatory PFR. The erraticism is also possibly influenced by other AEMO dispatch control inadequacies and amplified by the assignment of the overly tight mandated PFCB. Even though mechanical-hydraulic governors of the remaining steam-fired synchronous fleet have zero deadbands, they have natural reaction that present as deadbands of an inconsistent range but which are generally on average less than +-50mHz, generally more than +-15mHz but also zero sometimes. Prior to NEM commencement, most NSW steam turbine machines had frequency controller deadbands set no lower than +-50mHz which was the compromise setting for the controllers to best coordinate with the response from the mechanical-hydraulic governor reaction. System frequency in the NSW system prior to the NEM was well controlled and had no erraticism. The PFCB, being defined as +-15mHz, is set inside the average natural reactionary deadband resulting from mechanical-hydraulic governor action. Such assignment is therefore likely to be producing on a single unit, regular erroneous under and over reactions from mechanical-hydraulic governors in response to reactions from frequency controllers in the Unit controller set with the very tight PFCB imposed deadband of AEMOs PFRR and, in counter-reactions with all other machines, exacerbating the coordination inadequacy of the overall control, as controllers of different participants and AEMO's FCAS dispatch interact.

In support of appropriate attention to Rule 4.4.1(a), it was previously suggested that the standard needed to include quality targets for frequency conditions, from which, AEMO would be required, using enhanced frequency control investigations, coordinated approaches with participants and other automatic mechanisms, to improve the overall quality of the frequency condition being currently experienced.

AEMOs unwavering advice to the Panel that Mandatory PFR at a strictly applied PFCB is essential whilst being quieter on other quality control rationale is unfortunate and adoption of the PFCB advice by the Reliability Panel, without performing a detailed independent evaluation of present actual day-to-day frequency conditions in addition to considering the theoretical demonstrations from models that did not produce the erratic conditions, suggesting incompleteness of the models, means the market has now lost an opportunity in this FOS review to develop additional targets for quality that may have driven more effective overall control and removed the erraticism. The review has also missed the opportunity to determine a more balanced and overall market viewpoint on what the overall acceptable distribution of frequency should be, which the Operator would then be required to ensure the system meets, requiring from them a more dedicated effort to pursue AGC and Generator frequency control tuning to improve overall coordination. Instead, the draft determination is being made from incomplete, some overstated and some underemphasised advice from AEMO, from which, after obtaining modelled advice containing conditions that work in a theoretical system that has no uncontrolled erraticism in it, the proposed outcome is to reinforce AEMO's rigid PFCB assignment even though it is possibly exacerbating the erraticism, delivering worse coordination and smoothness in the second-to-second frequency condition.

**The GHD Advice**

The GHD advice is very informative and detailed showing good diligence in the development of models and making sensible inference from the response of the model to various PFCBs.

However, from examining the observable detail, the models do not produce frequency conditions that completely match actual system conditions and are therefore lacking relevant complexity. This outcome weakens the conclusions that can be made from the modelling advice. The erraticism of the frequency condition currently on the system greatly exceeds the variation in frequency predicted in the GHD-modelled results for the system with applied +-15mHz deadbands on machines. These variations that exist on the system ought not be acceptable or should be assigned some amplitude limits because they could become particularly troublesome to the system if the amplitude of them increases beyond 100mHz as sometimes seems to be the tendency on occasion. Another RoCoF standard could have been assigned for the NOFB in order to do this. However, the fact that actual frequency conditions, produced by implemented Mandatory PFR and easily examinable from daily records, demonstrate frequency variations wider than conditions predicted by the GHD model with +-15mHz deadbands, relied upon by the Panel in determining the PFCB remain at AEMO's designed +-15mHz, is a major weakness in the PFCB decision of the draft determination. The modelling advice suggests a lower PFCB is better, which it is agreed is demonstrable from the modelling structure developed but factual frequency data suggests the steadiness expected by the very narrow default PFCB is not present in the real system and is more similar to the model's predicted conditions for deadbands set at 50mHz. It is also demonstrable that the erraticism amplitudes are either largely unchanged by the Mandatory PFR or are, at worst, increased by it. Therefore, whilst Mandatory PFR has narrowed the overall limits of the experienced distribution, faster variations of 50mHz peak to peak amplitude occurring over twenty to thirty seconds continue to exist and appear sometime to be tending towards 100mHz in amplitude. In contrast to the modelling findings, Delta Electricity considers that experimentations by the operator with wider and more varied deadbands on Unit controllers

across the NEM would be able to produce the same overall frequency quality conditions as exist in the present NEM but may also reduce uncoordinated corrections that unnecessarily cause all machines to work harder than is required and which are generally inefficient. The lack of guidance in the FOS about quality of frequency control inside the NOFB which could steer an operator more definitively towards experiment to find better overall frequency control outcomes, possibly resulting from deadbands set at more sensible levels somewhere between 150mHz and 15mHz, presents the appearance of AEMO having largely informed both GHD and the Panel as to what AEMO needs in the FOS rather the panel determining what the market needs in the FOS.

If Mandatory PFR at PFCB deadbands is not controlling frequency erraticism, as is apparent from examination of the real data, then Delta Electricity maintains that additional quality targets are needed in the FOS guiding the expected performance level of all frequency control to achieve a smoother overall frequency condition and a more sensible frequency distribution during normal operation. The consistent double-humped shape of the existing distribution, centred around 50Hz but with peaks either side of the nominal, is not representative of the acceptable conditions that existed in pre-NEM electrical systems and demonstrates a lack of coordination in frequency control. The two sharp peaks either side of 50Hz were not evident prior to Mandatory PFR and is therefore considered to be occurring now due to excess uncoordinated PFR reactivity and inappropriate rigid adoption of a deadbands set in large numbers of machines exclusively at the defined PFCB rather than set by careful examination of machine interactions to ensure each machine coordinates well in reaction to others and to energy and FCAS dispatch. This FOS review has missed the opportunity to consider the potential wear and tear impacts of ineffective coordination of overall frequency control and to report the economic and technical benefits that smoother frequency conditions would deliver to the FCAS marketplace and all machines. Without the assignment of quality targets, AEMO are excused from applying greater diligence and effort in their obligations under the Rules 4.4.1(a) and (b). A greater effort in this direction is considered essential to minimise machine disruption and would also reduce volatility in FCAS prices and, subsequently improve overall PFR performance, reduce frequency control causation, and produce smoother conditions that would reduce the longer term maintenance burdens not only for NEM participants but also for all AC electrical equipment in industry and households of the NEM.

The costs referred to by GHD in evidencing that a narrower PFCB is cheaper overall have also not considered the possibility that assigning a PFCB narrower than the natural frequency controllability of mechanical-hydraulic governors with zero deadband, will be increasing the tendency for damage in expensive steam and hydroelectric turbine components. Such components cannot be repaired in service and will therefore, if defects and unit outage downtime increase as a result of the erraticism, at least contribute to increasing the potential for unserved energy but also carry with it greater potential for earlier departure of units already expected to be retiring from the market in the near future.

**Possible Future Considerations in the Next Review**

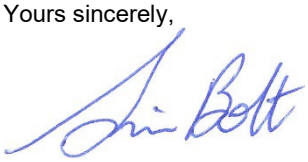
As can probably be inferred from the above comments, Delta Electricity considers a future FOS review that develops targets for sensible frequency quality might be beneficial from which an operator can drive a more compete frequency control agenda, tune AGC and FCAS market dispatch quantities to greater smoothness of overall frequency control and, at the same time, reduce excessive wear and tear on all electrical machines operating in the NEM. The quality target ought to be as simple as requiring that frequency conditions recorded at central positions in each region chart an acceptable bell-shaped distribution centred around 50Hz as can be easily monitored in observable day to day frequency conditions or it may also need some specialised RoCoF measures for NOFB conditions. In the next review, the Panel are encouraged to consider the issues of the quality of the overall frequency condition more independently from any advice provided by AEMO and to determine quality targets for overall frequency control that AEMO is required to meet. However, it is also understood that AEMO does not actually need quality standards to be already seeking improved frequency control in compliance with Rule 4.4.1(a) and it is acknowledged that AEMO, at forums held for this review, have commented on the possibility that they will act in this direction in the near future, which would be welcomed.

Delta Electricity also considers the decision to undertake the next review the FOS following two years of operation of the new PFR incentivisation contribution factor process and performance payments, not expected to start until July 2025, is too far in the future. An earlier revision is recommended or may otherwise be prompted should some sort of inadequate frequency condition, resulting from erraticism, contribute to a large system event. PFR incentivisation may not incentivise participants greatly enough to improve individual PFR delivery. PFR delivery from individual units is also not the only solution in the overall frequency control effort required as evidenced by the continued erraticism despite Mandated PFR. Delta Electricity expects that Mandatory PFR and the rigid assignment by AEMO on common PFCB deadband adoption everywhere across the NEM may need reconsidering inside four years. However, it is also

acknowledged that AEMO do not need further Rule changes or further FOS reviews to support actions they may undertake, or should be already undertaking, to reduce erraticism in the overall frequency condition. Rule 4.4.1(a) already provides an incentive to AEMO to do so.

If the Panel wishes to discuss any aspect of this letter, please contact Simon Bolt on (02) 4352 6315 or simon.bolt@de.com.au.

Yours sincerely,



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